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ABSTRACT

The purpose of this paper is to discuss the interactive ability of Web-based instruction. The first part of the paper analyzes interaction and instructional theories. Discussion includes Bruner's three-form theory; Gagne conditions of learning; Merrill instructional transaction theory; and Spiro cognitive flexibility theory. The second part of the paper focuses on interaction in Web-based instruction. Discussion includes content and instruction interaction; social and interpersonal interaction; asynchronous and synchronous communication; and individual and group communication. (Contains 22 references.) (AEF)

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# Enhancing Interactivity into Web-based Learning Environments

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# Building Interaction into Web-Based Instruction

Shu-sheng Liaw


## Abstract

Instructional design for educational purposes is the systematic design of teaching and learning environments and instructional systems. After the Internet widespread, the World Wide Web (WWW) is more popular for educational instruction. Typically, the Web-based instruction will be at least as successful at fostering students' learning and interaction as are classroom teaching techniques used on campus. The purpose of this paper is to discuss the interactive ability of Web-based instruction. The first part of the paper will analyze interaction and instructional theories, the second part will discuss interaction in Web-based instruction. An example of interactive web-based instruction will be presented for explanation of instruction design.

Keyword: Instruction design, interaction, World Wide Web.

## Introduction

Instructional design for educational purposes is the systematic design of teaching and learning environments and instructional systems. Instructional design may include various facets of didactic methods and media, such as direct instruction, self-instructional textbooks, and instructional video, as well as computer based training, interactive multimedia, and elements of distance learning (Gros, Elen, Kerres, Merrienboer, and Spector, 1997). After Internet widespread, the World Wide Web (WWW) is more popular for educational instruction. Within the context of k-12 or higher education, instruction designers are usually asked to make sure that instructions designed for Web-based learning environments will be at least as successful at fostering students' learning and interaction as the classroom teaching environment on campus. Concerning "interaction", Gilbert and Morre (1998) noted:

**Are we designing courses in a particular fashion simply because the Web allows us**

**to include popular features that we call 'interactive,' or do we have a clear idea that**

**we are using these new features because they will allow us to use truly interactive and adaptive techniques that will enhance student learning?**

Interaction can be defined as "sustained, two-way communication among two or more persons for purpose of explaining and challenging perspectives" (Garrison, 1993, p.16). In addition, Gilbert and Moore (1998) indicated that interaction is two-way communication among two or more people within a learning context, with the purposes either task/instructional competition or social relationship building. In an educational learning environment, interaction is typically between a student and instructor, or among students. The strength of this ongoing interaction between instructors and students distinguishes the learning experiences from independent learning or one-way, mass communication programs. In a learning environment, interaction does not simply occur but must be intentionally designed into instructional programs. How instruction is designed is typically based on the designer's interpretation of the world, filtered through her/his instructional philosophy (Berge, 1999).

A common definition of interaction in computer-medicated learning is "the learner actively adapts to the information presented by technology, which in turn adapts to the learner, a process more commonly referred to as feedback" (Weller, 1988). The real interactive transactions in learning involve real-time, dynamic, and mutual give-and-tack between the instructional system and learner, including exchanges of relevant information (Merril, Li, & Jones, 1990). Within the ability of interaction, the Web-based instruction typically provides two categories of interactivity that are perceived to be common in face-to-face instruction (Gilbert & Moore, 1998): social interactivity and instructional interactivity. Social interaction may be simulated by e-mail, listservers, newsgroups, or any other two-way communication media binding on Web-based instruction. Instructional interactivity may be duplicated through immediate feedback, questioning, control of pacing, sequencing, and other interactive controls. Although Web-based instruction offers interactivity, opponents argue that it unable to duplicate the truly face-to-face learning environment.

The purpose of this paper is to discuss the interactive ability of Web-based instruction. The first part will analyze interaction and instructional theories, the second part will discuss interaction in Web-based instruction, and the third part will provide an example of interactive web-based instruction.

## Interaction and Instruction theories

Interaction is a critical factor for teaching and learning. Typically, interaction is important for various types of learning and important for learning satisfaction. Additionally, Berge (1999) stated "interaction is central to the expectations of teachers and learners in education, and to that extent it is a primary goal of the educational process." Generally, for these reasons and to provide the necessary feedback between learners and instructor, interaction will continue to be seen as a critical component of education.

In contrast to learning through passive exposure to information, interaction is often especially valued for its ability to engage the learners in the material because the active orientation required of the learners is believed to provide a motivational boost to learning that traditional learning does not provide (Petraglia, 1998). In this view, interaction permits learners to faithfully replicate learning in everyday situations by providing them with opportunities to determine, at least in some degrees, the form of instruction they receive.

While it is a widely held belief that a high level of interaction is desirable and positively affects the effectiveness of education, it is still necessary to clarify the relationship between interaction and instructional theories. Basically, four theories study this relationship: **Bruner three-form theory, Gagne conditions of learning, Merrill instructional transaction theory**, and **Spiro cognitive flexibility theory.**

**Bruner three-form theory**

From Bruner's viewpoint (1966), there are three ways in which individuals represent the real world. Through ***action, icons and symbols***, learners can convert reality into their own unique portrayal of reality. Typically, ***action*** includes enactment and demonstration. ***icons*** include images and pictures, and ***symbols*** include words and numbers. The *active form*, which is based on stimulus-response theory, is the state of doing. The *iconic form* is a summary image or a mental picture of a path or pattern. The *symbolic form*, which

consists of language, is an abstract form since the word is a disconnection from the reality it represents. The three forms of representation are based on this argument: a theory of development must be connected to a theory of knowledge and to an effective theory of instruction (Presno, 1997).

As Bruner pointed out, it is available to modify instruction according to the nature of the subject and to the nature of the learner when instructors lean more heavily toward the abstract, symbolic form for advanced students. And Presno (1997) suggested that it is possible to develop more creative and efficient ways to help students to better represent computer-reality using action, images and language. Bruner also stated (1966), "Teaching by telling is out of context of action." (p.153). It is clear that learning by doing is a powerful way of learning. Indeed, doing is results of interaction in learning and teaching activities.

**Gagne conditions of learning**

Gagne (1985) proposed a descriptive theory of knowledge consisting of five outcome categories: intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes. Based on the information, Gagne's theory is a systematic instruction and learning process. Moreover, he also proposed a descriptive theory of strategy that consist nine events of instruction: gaining attention, informing the learner of objective and activating motivation, stimulating recall of prior knowledge, presenting the stimulus material, providing learning guidance, eliciting performance, providing feedback, assessing performance, and enhancing retention and transfer. From Gagne conditions of learning, learning activities are the two-way transaction to stimulate learning capacity. In other words, this two-way communication may help learners to create their own knowledge through learner's individual background. Individual new information and knowledge creation is based on personal particular backgrounds and the results of two-way interaction between learners and instructors.

**Merrill instructional transaction theory**

Merrill and the $ID_2$ research group (1996) proposed instructional transaction theory to describe knowledge in terms of three types of knowledge objects: entities, activities, and processes. They also identified six types of interrelationships among knowledge objects: components, properties, abstractions, associations between entitles, activities, and processes. According to instructional interaction, instructional transaction theory proposed a set of instructional algorithms that called transaction shells. A transaction shell consists of rules for selecting and sequencing knowledge objects. It also consists of a sequence of messages to knowledge objects which cause them to display a multimedia resource representing the knowledge object, display their name or description, change their location or property values, and consequently the multimedia resources associated with these change property values.

Moreover, instructional transaction theory identifies several classes of instructional transactions that include identification, execution, explanation, judging, classification, generalization, and transfer. Based on these instructional transactions, learners may assume to be stimulated effectively by the processes of transactions. When designing instruction system that based on instructional transaction theory, it may carry out six important responsibilities. First, selecting the knowledge objects for instruction. Second, sequencing these knowledge objects. Third, selecting the transactions appropriate for teaching a selected knowledge object or set of knowledge objects. Fourth, sequencing

these transactions. Fifth, enacting these transactions by conducting the interaction with the learners. And sixth, adapting the way a given transaction is enacted to meet the needs of an individual learner being taught (Merrill, Li, & Jones, 1992). Indeed, instructional transaction theory indicates that interaction is a crucial factor that can assist learners to promote learning effectively with a given configuration of abilities and aptitudes.

**Spiro cognitive flexibility theory**

Spiro cognitive flexibility theory emphasizes the real world complexity and ill-structuredness of many knowledge domains (Spiro, et al, 1991). From an ill-structured aspect of knowledge, advancing knowledge acquisition, such as attaining an understanding of important elements of conceptual complexity, the ability to use acquired concepts for reasoning and inference, and the ability to flexibly apply conceptual knowledge to novel situations, can be facilitated by the principles of this theory. This cognitive flexibility theory is systematically applied to an instructional theory. Generally, this theory has the following characteristics: first, random access. Second, the major learning activity is a nonlinear exploration of the learning environment. Third, multiple representations of the content are presented (Maddux, et al, 1997; p. 214).

Cognitive flexibility theory points out that traditional instructional designs, such as textbooks, lectures and computer-based drills, are inadequate for implementation within ill-structured domains because they depend on organized and linear techniques. For a learner to fully comprehend the complexity and erratic variability of information, it must be accessible to the learner in a manner that more closely mimics the non-linear nature of the domain (Brown, 1995). Based on the interactive view, this non-linear nature can give learners more opportunities to interact with instruction and with individual backgrounds. In other words, nonlinear interaction may assist learners to create their own knowledge.

## Interaction in Web-based instruction

When using technology to assist interaction between learners and instruction or learners and instructor, the quality of learner interface should be considered at first. Neuman (1995) noted that the computer's potential for interactivity has "become the focus of irrepressible optimism" among educational technologists (p.52). In general, learner interface interaction addresses the relationship between the learners and the technology that is being used to access instructional materials and to communicate with the instructor and other learners. In Web-based instruction, interaction is not just to select simple menu or click objects on the screen. Instead, the interaction should involves complex activities by the learners, such as engaging and reflecting, annotating, questioning, answering, pacing, elaborating, discussing, inquiring, problem-solving, linking, constructing, analyzing, evaluating, and synthesizing.

Web-based instruction, the technology has capability such as hypermedia and tools such as e-mail, listservers, newsgroups (usenet), synchronous chat, and Web-based computer conferencing. Typically, Web-based instruction offers several interactions, such as providing content and instruction interaction, offering social and interpersonal interaction, and enabling either asynchronous or synchronous communication among participants, and allowing individual and group communication.

**Content and instruction interaction**

The World Wide Web is a hypermedia technology that allows all individuals with a browser to transfer information from thousands (or more) of possible sources to

themselves in a nonlinear fashion. The native attributes of the Web system include the capacity to transfer multimedia files completely intact to anyone or any network (Gilbert & Moore, 1998). Based on the native attributes of the Web system, content and instruction interaction, such as searching instruction, linking content, or reading text, can be able to deal with. Generally, users of the Web system have full control over of the learning situation. And this interaction gives users dynamic control of information. In addition, the non-linear fashion can be instantly called up in a consistent manner, irrespective of the structure of the information or resources (Yang, 1996). Based on non-linear media form, the Web system allows learners to explore abundant and diverse bits of information in their own ways. Unlike traditional linear instruction interaction, this multiple and non-linear content interaction leads learners to reflect more on their own knowledge construction. In other words, this interaction approaches constructivist pedagogy (Lacy & Wood, 1993).

**Social and interpersonal interaction**

Social and interpersonal interaction usually is a face-to-face communication. In general, when discussing social and interpersonal interaction in Web system, face-to-face communication is not necessary to happen all the time. For instance, while learners need to ask questions or instructor needs to answer the questions, Web-based instruction provides e-mail, listservers, newsgroups or online conferences. Unlike face-to-face social and interpersonal communication, with Web-based instruction binding an online system, such as the Internet, this multi-user network provides enormous potential for social and interpersonal interaction (Yang, 1996). In this system, learners and instructor (or learners and learners) can engage in side-by-side and online questioning, answering, discussion, debate, or negotiation.

In general, social interaction tends to have elements of mutuality, flexibility, and bi-directionality that are not as frequently found in purely instructional interaction (Gilbert &Moore, 1998). Moreover, the social interaction in a course can also have significant effects on learning outcomes. In other words, social and interpersonal interaction can directly foster content and instruction interaction. Although it is important to distinguish between interaction that is primarily social in nature and interaction that embraces instructional objects, it is possible that mixtures of the two general classes of interactions are common. For instance, when using e-mail or listservers, it can devolve into purely social interaction, but it can also be a highly effective tool for interacting about instructional objects.

**Asynchronous and synchronous communication**

A web-based system can also offer asynchronous and synchronous communication. Asynchronous communication, such as e-mail, listservers, and newsgroup, is in some manner technologically mediated and is not dependent upon instructors and learners being present together at a specific time to conduct teaching and learning activities (Berge, 1999). In asynchronous communication, learners can work at their own convenience when or where they want to be. In addition, learners can control the pacing of instruction by themselves. Asynchronous communication gives learners more time to reflect on their own ideas and encourages them to do more critical thinking.

Synchronous communication occurs in real time, such as online conference or chat. All participants, including instructors and learners, in the interaction must be present, although not necessarily at the same physical location. Typically, synchronous

communication allows students to get practice at fast interaction. When oral discussion in an online chat, the quality of the arguments is enhanced and thinking is more creative than without this kind of interaction (Warschauer, 1995). The online chat in the Web system thus serves the roleof thinking device for collaborative construction of knowledge.

**Individual and group communication**

For learning to occur, based on the constructivist pedagogy, individuals using their experiences as a foundation can construct knowledge personally from internal representations. In learning activities, knowledge is based on individual constructions that are not tied to any external reality, but rather to the learner's interaction with an external world (Lacy & Wood, 1993). Typically, while processing and integrating instructional content in schools, much content quickly becomes "inert" as it has little relevance to the life circumstances of the learners (Gagne, Yekovich, & Yekovich, 1993). Hence, the exploration of "just-in-time instruction" is necessary for learners to create their own knowledge. The multiple linkages and perspectives of web-based instruction can provide a learner-objective environment to assist learners to link and search for knowledge that can interact with their own prior experiences. Another aspect of individual interaction includes reflection, meaning learners exercise control over what is learned. In fact, a large part of teaching is promoting the individual communication that helps to integrate new experiences with those already existing and to organize them into meaning (Warschauer, 1995).

Typically, group communication is collaborative learning. In general, collaborative learning can help individuals to make progress through their zone of proximal development by the activities in which they engage (Vygotsky, 1978). When learners have opportunities to interact with others and their instructors about the instruction or content, they have opportunities to build their own knowledge. In addition, they can share their own knowledge with others. Much of learning inevitably takes place within a social context, and the process includes the mutual construction of understanding (Bruner, 1971). Indeed, group communication offers the opportunities for learners to gain the motivational support of fellow learners and instructors, develop critical judgement, participate in problem-solving, and often has the potential for other incidental learning (Chacon, 1992). When listservers, newsgroups, or online conferences are binding into a Web-based system, the group communication can be offered through either asynchronous or synchronous methods.

## Implementation of interaction into Web-based instruction

When implementing a Web-based instruction, Gillbert and Moore (1998) suggested the designer needed to undertake a five-step setting. First, defining the types of social and instruction interactions desired for a particular Web-based course. Second, determining the personnel, technology, and financial resources available. Third, defining the levels of instructor control, learner control, and group influence desired over that interaction. Having defined this step, the instruction designer can determine which design tools will be used. Fourth, using native capabilities of Web-based design tools to the maximum extent possible, but avoiding the extensive design work that is involved in programming tools with advanced groupware or Web tools. And fifth, completing programming as required, implementing the missing features of instructional interaction, and using the

most open-ended tools familiar to the designer. In addition, the security of Web system should be considered carefully to avoid computer viruses and computer system crashes.

Typically, the following Web-based design tools may foster interaction between learners and instructor. First, Web browsers, such as Netscape Communicator and Internet Explorer, can provider nonlinear, multiple linkage and hypermedia capabilities. Second, such commercial groupware products as Lotus Notes and Microsoft Exchange advertise easy facilitation of group and social interactions. Third, programming tools, such CGI (common gateway interface) languages as C++, perl, java, or script languages, offer instructional designers create particular interactions. And fourth, hybrid course design programs, like WebCT, or blackboard, allow designers to add interactions, such as searching, asking, answering, submitting, and presenting instructional content or attending synchronous and asynchronous discussion groups, and bulletin boards. The following figure presents the interaction of Web-based instruction.

Figure 1: example of interaction into Web-based instruction

## Conclusions

Critical to understanding interaction in education is to realize that interaction involves a continuum from content interaction to social interaction, from instructor-centered to learner-centered, and from individual-objected to group-objected. Typically, each medium has its own particular characteristics for instructional purpose when designing interaction. In a Web-based learning environment, the key features of interaction can be content/instruction or social/interpersonal interaction, asynchronous or synchronous communication, and individual or group communication. From the educational viewpoint of interaction, more interactive between learners and instructor or among learners, more enable learners to learn and develop by self-discovery and personal insight.

But a mismatch of the use of interaction, synchronicity, and technology can lead to loss of the learner's attention, boredom, information overload, and frustration (Berge, 1999). So one challenge, for those designing such learning environments as Web-based or other technology-based, is to seriously consider which presentation method will best enhance the presentation of information and facilitate interaction among learners and faculty. In Web-based instruction, the dilemma is when instructional programs add the complexity needed for the design of instructional interaction, it become itself increasingly complex to use (Gilbert & Moore, 1998). In other words, increasing the flexibility of interaction will increase the complexity of Web-based instruction. Although still having several dilemmas, it is hoped that as Web-based instruction development progresses, simple-to-use tools will be developed that will, in turn, allow for the inclusion of complex interactions. In addition, it can also be expected that we will see an environment that not only equals traditional instruction but also provides opportunities that go far beyond it.

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